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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/661,831	09/12/2003	Qing Hu	101328-0178	7713

21125 7590 07/14/2005

NUTTER MCCLENNEN & FISH LLP
WORLD TRADE CENTER WEST
155 SEAPORT BOULEVARD
BOSTON, MA 02210-2604

EXAMINER	
VAN ROY, TOD THOMAS	
ART UNIT	**PAPER NUMBER**
2828	

DATE MAILED: 07/14/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	**Application No.** 10/661,831	**Applicant(s)** HU ET AL.	
	Examiner Tod T. Van Roy	**Art Unit** 2828	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-26 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-26 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 02/27/2004.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1, 5-8, 13, 16-17, and 22-24 are rejected under 35 U.S.C. 102(b) as being anticipated by Xu et al. (Xu and Hu, "Electrically pumped tunable terahertz emitter based on intersubband transition," American institute of Physics (1997)).

With respect to claim 1, Xu discloses a quantum cascade laser, comprising a semiconductor heterostructure providing a plurality of lasing modules connected in series (col.1 lines 25-3), each lasing module comprising a plurality of quantum well structures collectively generating at least an upper lasing state, a lower lasing state, and a relaxation state (fig.1) such that said upper and lower lasing states are separated by an energy corresponding to an optical frequency in a range of about 1 to about 10 Terahertz (fig.3), and wherein electrons populating said lower lasing state exhibit a non-radiative relaxation via resonant emission of Lo-phonon into said relaxation state (col.2-3 lines 10-2).

With respect to claim 5, Xu discloses the cascade laser to operate in pulse mode (col.4 lines 9-21).

With respect to claim 6, Xu discloses the cascade laser to comprise an electrical contact for applying a bias voltage across the heterostructure (col.3 lines 44-50).

With respect to claim 7, Xu discloses that the bias voltage causes a relaxation state of each lasing module to be in substantial resonance with an upper lasing state of an adjacent module to allow resonant tunneling of electrons there between (col.3 lines 28-31).

With respect to claim 8, Xu discloses that electrons populating an upper lasing state of each module exhibit a vertical optical transition into a lower lasing state of the module (col.6 lines 15-18, disclosing the benefits of utilizing the vertical transition).

With respect to claim 13, Xu discloses the cascade laser to comprise an upper contact layer and a lower contact layer between which said semiconductor heterostructure is disposed (col.1 lines 27-28).

With respect to claims 16-17, Xu discloses the contact layer to be formed of heavily doped GaAs with a doping level of about 3x10^18 (col.1 lines 25-28, where 2x10^18 is about 3x10^18).

With respect to claims 22-23, Xu discloses the cascade laser to be formed on a GaAs substrate (col.1 lines 25-26).

With respect to claim 24, Xu discloses the cascade laser as outlined in the rejection to claim 1, wherein the laser would inherently function as an amplifier to

incoming radiation in the 1 to 10 THz range, and additionally an input port and output port would be located at either facet of the device.

Claims 1, and 9-10 are rejected under 35 U.S.C. 102(b) as being anticipated by Williams et al. (Williams, et al., "Narrow-linewidth terahertz intersubband emission from three-level systems," American Institute of Physics (1999)).

With respect to claim 1, Williams discloses a quantum cascade laser, comprising a semiconductor heterostructure providing a plurality of lasing modules connected in series (col.2 lines 1-13), each lasing module comprising a plurality of quantum well structures collectively generating at least an upper lasing state, a lower lasing state, and a relaxation state (fig.1b) such that said upper and lower lasing states are separated by an energy corresponding to an optical frequency in a range of about 1 to about 10 Terahertz (fig.3), and wherein electrons populating said lower lasing state exhibit a non-radiative relaxation via resonant emission of Lo-phonon into said relaxation state (col.1 lines 34-38).

With respect to claim 9, Williams discloses the quantum cascade laser of claim 1, wherein in each of said lasing modules, said relaxation state is characterized by a wavefunction exhibiting substantial amplitude in a first one of said quantum wells (fig.1a E1 in W1), said upper lasing state is characterized by a wavefunction substantially concentrated in quantum wells other than said first quantum well (fig.1a E3 in W3), and said lower lasing state exhibiting sufficient amplitude in said first quantum well so as to

cause a substantial phonon coupling between said lower lasing state and said relaxation state (col.1 lines 34-38).

With respect to claim 10, Williams discloses said upper and lower lasing states to exhibit substantial amplitudes in at least one of said quantum wells (fig.1a E3,E2 in W2,W3) so as to allow a vertical optical transition between said upper and lower lasing states (col.3 lines 17-19, which would allow for the vertical transition to occur).

Claims 1, 14-15, and 21 are rejected under 35 U.S.C. 102(b) as being anticipated by Kohler et al. (Kohler, et al., "Terahertz semiconductor-heterostructure laser." Nature, 417, 156 (2002)).

With respect to claim 1, Kohler discloses a quantum cascade laser, comprising a semiconductor heterostructure providing a plurality of lasing modules connected in series (fig.1a), each lasing module comprising a plurality of quantum well structures collectively generating at least an upper lasing state, a lower lasing state, and a relaxation state (fig.1a) such that said upper and lower lasing states are separated by an energy corresponding to an optical frequency in a range of about 1 to about 10 Terahertz (abs. lines 14-15), and wherein electrons populating said lower lasing state exhibit a non-radiative relaxation via resonant emission of Lo-phonon into said relaxation state (col.1 lines 39-42, speaking of the ability to allow for population inversion).

With respect to claim 14, Kohler discloses the heterostructure to be formed of a stack of alternating GaAs and Al(0.1)Ga(0.85)As layers (col.2 lines 10-12).

With respect to claim 15, Kohler discloses the heterostructure to have a thickness in a range of about 1 to about 10 um (fig.1 caption, 1 period of module = .1049um with 104 periods, col.4 lines 17-20, which gives a total thickness of 10.9um which is about 10um).

With respect to claim 21, Kohler discloses the number of lasing modules to be within a range of about 100 to about 200 (col.4 lines 17-20, 104 periods).

Claims 1, 2, and 25-26 are rejected under 35 U.S.C. 102(e) as being anticipated by Goodhue et al. (US 2003/0219052).

With respect to claim 1, Goodhue discloses a quantum cascade laser, comprising a semiconductor heterostructure providing a plurality of lasing modules connected in series (abs. lines 9-10), each lasing module comprising a plurality of quantum well structures collectively generating at least an upper lasing state, a lower lasing state, and a relaxation state (fig.55a,b) such that said upper and lower lasing states are separated by an energy corresponding to an optical frequency in a range of about 1 to about 10 Terahertz ([0261], 4.2 THz), and wherein electrons populating said lower lasing state exhibit a non-radiative relaxation via resonant emission of Lo-phonon into said relaxation state ([0088]).

With respect to claim 2, Goodhue discloses the quantum cascade laser of claim 1, wherein said non-radiative relaxation of the lower lasing state into the relaxation state at a selected operating temperature of said laser is faster than a corresponding relaxation rate of said upper lasing state into said lower lasing state (table 9, t21 faster

than t32), and wherein said resonant Lo-phonon emission selectively depopulates the lower lasing state such that a ratio of a lifetime of said upper lasing state relative to lifetime of said lower lasing state is at least about 10 ([0264], t2=.8ps, t3=10ps, t3/t2=12.5ps).

With respect to claim 25, Goodhue discloses a quantum cascade laser of claim 1, comprising a semiconductor substrate ([0260]), wherein vertical transitions between the upper and lower states generate radiation (fig.54b, fig.60b, upper and lower lasing states, E4 and E3, strongly coupled in the quantum well which would allow for vertical transitions and radiation emission).

With respect to claim 26, Goodhue discloses the phonon scattering rate of electrons from the lower lasing state to the relaxation state to be in the range of about .1 to about .6 ps (table 9, t21=.06ps which is about 1 ps).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 3-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu in view of Tredicucci et al. (Tredicucci et al. "High performance interminiband quantum cascade lasers with graded superlattice," Appl. Phys. Letter. 73, 2101 (1998)).

With respect to claims 3 and 4, Xu teaches the cascade laser as outlined in the rejection to claim 1, but does not teach the laser to generate radiation at temperatures above 130K. Tredicucci teaches a cascade laser which operates at temperatures up to 295K (col.4 lines 20-26). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the cascade laser of Xu with the operating temperature of Tredicucci in order to provide for a device that does not require additional extreme low temperature cooling equipment to be used in conjunction with its operation.

Claims 11-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu in view of Faist et al. (Faist, et al., "Bound-to continuum and Two-phonon Resonance Quantum-cascade Lasers for High Duty Cycle, High-Temperature Operation IEEE (2002)).

With respect to claim 11, Xu teaches the cascade laser as outlined in the rejection to claim 6, but does not teach the presence of a fourth state in resonance with the lower lasing state. Faist teaches a cascade laser wherein a fourth state is in

resonance with the lower lasing state (fig.7, state 2 in resonance with lower lasing state 3). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the cascade laser of Xu with the four state system of Faist in order to facilitate faster population inversion and shorter scattering times (Faist, col.9 lines 25-30).

With respect to claim 12, Xu and Faist teach the four level cascade laser as outlined in the rejection to claim 11, and further teach the benefits of utilizing LO-phonon scattering into the relaxation state (Xu, col.2-3 lines 10-2).

Claims 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu in view of Unterrainer et al. (Unterrainer et al., Quantum cascade lasers with double metal-semiconductor waveguide resonators," Appl. Phys. Lett. 80, 3060 (2002)).

With respect to claims 18-20, Xu teaches the cascade laser as outlined in the rejection to claim 1, wherein it was further taught that the heterostructure was surrounded by heavily doped semiconductor layers in the rejection to claim 13. Xu does not teach the use of a waveguide formed by two metallic layers sandwiching the heterostructure. Unterrainer teaches a cascade laser that uses two metallic layers to sandwich heavily doped semiconductor layers (col.2 lines 23-28, speaking of the semiconductor layers) and the heterostructure (col.3 lines 25-27) to form a waveguide. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the cascade laser of Xu with the metallic waveguide of Unterrainer in order

to increase confinement factors (Unterrainer, abs.) allowing for better utilization of the gain region which lowers threshold current densities (Unterrainer, col.4 lines 40-47)

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970);and, *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 1, 8, 13-14, 16-20, and 24-25 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 9-14, and 18 of copending Application No. 10661832. Although the conflicting claims are not identical, they are not patentably distinct from each other because:

Claim 1 is taught by claims 1 and 9 from '832.

Claims 8 and 25 are taught by claims 1 and 14 of '832.

Claim 13 is taught by claims 1 and 10 of '832.

Claim 14 is taught by claims 1 and 13 of '832.

Claims 16-17 are taught by claims 1, and 1-12 of '832.

Claims 18, and 20 are taught by claim 1 of '832.

Claim 19 is taught by claims 1, and 10-11 of '832.

Claim 24 is taught by claim 18 of '832.

This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tod T. Van Roy whose telephone number is (571)272-8447. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Minsun Harvey can be reached on (571)272-1835. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

TVR

MINSUN OH HARVEY
PRIMARY EXAMINER